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Computer Generated Forces
Future Needs

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Notes for Slide 1

Summary

This presentation provides a summary of the future needs for computer generated forces. It provides a view of the future security environment, as this establishes some of the new challenging problem areas for the application of CGFs. Technology areas important to future CGFs are reviewed, and some overarching goals are given.

Topics

- Future Environment
- Key Needs
- Main Goals for Computer Generated Forces

Notes for Slide 2

This section highlights the key goals for CGF development.

CGFs are becoming increasingly useful to all defense analysis areas. The main driver for future research will be in the use of CGFs for experimenting with future warfighting concepts.

Future Environment

- Adversaries with advanced technologies
- New warfighting concepts
- Information technologies
- Challenges
  - Complex systems and assessments
  - Experimentation

Notes for Slide 3

The primary long term influence on our military will be the ready acquisition of advanced technologies by our adversaries. Future conflicts will not have the same approximate balance among the participants and will not always use the doctrine of massing forces to achieve control. New technologies applied against new targets (e.g., computer networks) will create asymmetries in forces and what they can accomplish.

Understanding this future environment requires experimentation. New doctrines are needed that remain effective against the always improving and evolving threats. These new doctrines will involve both integration of new technologies into existing systems, plus entirely new types of capabilities.

Information technologies will be central to these changes. Advanced sensors will provide pervasive coverage of the battlefield. Advanced hardware, software, communications, storage, and displays will make this information universally available. Significant efficiencies in support functions and logistics will be enabled by these technologies.

Notes for Slide 3 (Continued)

The challenge is two-fold. First, the analyses of new capabilities must address the highly variable capabilities of the threats, and must determine future needs in an integrated context. Information technologies will enable rapid changes in tactics. New trade-offs among systems and their capabilities are now possible. New and more intelligent behaviors in the CGF systems are essential here.

Second, to experiment with new doctrines, we must learn how to define and assess our requirements for information technologies. The foundation of this work will be experiments in which humans work in a simulated environment populated by computer generated forces.

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Key Needs

- Need to explore future military environments
- Need new tools for experimentation
- CGFs are key examples of such tools

Notes for Slide 4

Nations need adequate means to explore future military environments. The rapid acquisition of advanced technology by our adversaries will require us to develop dramatically new capabilities, likely based on information intensive systems. In turn, new doctrines will evolve whose forces structures and command structures are different than today's. New types of military operations are expected to become more common; for example, out of area operations, shorter preparation time, and involvement with new coalition partners.

Understanding this future environment requires experimentation. New doctrines must remain effective against threats that are evolving. We must develop a flexible, robust approach using existing systems (improved with new technologies) together with entirely new types of capabilities.

CGFs provide critical tools for these explorations, as they allow analyses of new command structures operating with hypothetical, future capabilities and forces. Using CGFs operating in synthetic environments, various threats can be examined in traditional and new settings (e.g., urban environments).

Notes for Slide 4 (Continued)

Recent advances in simulation technology and in CGFs make the potential of this use very important. CGFs may contain representations of higher echelon commanders and their staffs. CGF systems can populate synthetic environments with a full range of forces, both joint and combined. Among the most recent developments is the capability to have humans interact with the CGFs using their real world C3I systems.

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Main Goals for CGFs

- Computer Generated Forces is a set of technologies with broad Defence applications
- New applications of CGFs will need more intelligent and more autonomous behaviors
- Cost-effective development and use of CGFs depends on the ability to have shareable (among users, nations) representations and flexible system architecture

Notes for Slide 5

Computer Generated Forces is a set of technologies with broad Defence applications:

Important applications include using CGFs to explore innovative future concepts of operation, to serve as an integrative tool in operational environments, and to support training and exercises. For example, CGFs provide a new means to educate, train, and exercise decision makers about new roles in new partnerships.

New tools and techniques are available that can bring significant manpower, resource, and time savings when using CGF systems in all application areas. Critical technologies here include automated exercise set-up tools, man-machine interface techniques.

New applications of CGFs will need more intelligent and more autonomous behaviors

The advantages of achieving this are CGFs that are easily adapted to new situations and to rapid experimentation. User-centred experiments can provide data on how human work with new C3I capabilities. These data contribute to smarter CGFs.

To effect this, key technology areas for future development include co-operative planning, knowledge elicitation and collection techniques, methods to instrument humans in operational environments, and basic research that would join cognitive science and applied Artificial Intelligence.

Notes for Slide 5 (Continued)

Cost-effective development and use of CGFs depends on the ability to have shareable (among users, nations) representations and flexible system architecture.

The goal is to be able to create, in a cost-effective manner, appropriate specialised CGF systems that leverage the investments in the component CGF technologies made by independent groups. A key advantage of developing the underlying architectural structure is greater interoperability and compatibility among CGF systems.

Important characteristics to achieve include the ability for CGF systems to work seamlessly in real time applications with human participants, rapid development of new CGF systems, and greater use of multiple sources of data.

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Training and Exercising

- Primary use of CGFs
  - Support unit and team skills, procedures, staff functions, decision-making training
  - Support exercises at strategic, operational, and tactical levels
- Capability Gaps
  - Preparation time to construct large training, exercise venues limits their use
  - Gaps in representation of key functions
- Goals
  - More realistic simulations
  - Fewer resources required to set-up, run, and analyze
  - Greater ability to connect distributed participants

Notes for Slide 6

Training is an activity that is conducted to improve the basic knowledge and skills of individuals or teams. Staffs need to be trained in decision making, use of procedures, rules of engagement, doctrine, the methods available for directing subordinates and reporting to higher authorities and Nations.

Exercises are conducted at strategic, operational and tactical levels, not only to train individuals, as described above, but also to measure the ability of commands as a whole to execute a mission and identify weaknesses in existing capabilities. In this context, realism and diversity in planning situations are again important, together with the need to use existing Command, Control and Information Systems (CCIS) as much as possible.

Although the number of situations that need to be exercised has grown, lengthy and complex exercise planning limits the actual number of situations that can be exercised. As a result, Headquarters and forces are insufficiently trained and, due to the cost of LIVEX, seldom employed realistically. Moreover, the complete chain of command is rarely included, and it is not always possible to use actual CCIS.

There is lack of simulation available for strategic level operations that make extensive use of an exercise control group (technical control, DISTAFF, white cell, etc.), media and the political decision making process. Currently this type of exercise needs to be pre-scripted, especially combined/joint training, thereby preventing initiative and experimentation that could be introduced by free-play.

Notes for Slide 6 (Continued)

The support of exercises is manpower intensive and requires numerous participants for pre-planning meetings and to replicate the various command levels. Existing simulation models also require extensive manpower support.

Existing simulation models do not adequately represent the following functions, logistics, intelligence, social factors, economic factors, political factors, space factors, future C3I environments and special operations.

To prepare an exercise a long lead time is required due to a lack of: Quick access to synthetic environment, Unit and performance databases, Tools to select and develop scenarios, Compatibility of databases across simulation models, releasability of databases, Lack of Interoperability

The general goals and objectives are: 1) Ability to represent activities associated with crisis management, traditional warfare and peace support operations, 2) Reduced need for staff to travel by allowing them to function in their normal home environment and interact realistically using official military communications with other staff or computer simulations that represent the higher, lower or adjacent staff. CGF must be able to play commands not represented in the exercise and important for the training of the trainee, 3) Ability to rehearse potential courses of action that could be taken in the exercise, 4) Ability to conduct comprehensive post-exercise analysis which re-construct events and derive lessons for use in real-world operations, 5) Ability to link with national simulation systems to train small groups or individuals at their home location.

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Defense Planning

- Primary use of CGFs
  - Explore potential requirements for new systems, force structures
- Capability Gaps
  - Lack of ability to represent new missions, political considerations, joint operations, C3I systems
- Goals
  - CGFs that are easy to set up and allow flexible degree of command staff involvement
  - Representations of C3I interactions and effects

Notes for Slide 7

Defence Planning involves the identification of future (5 to 15 years) requirements to meet anticipated missions. These requirements are based upon guidance regarding the size and nature of these operations, their expected duration and the number of contingencies that nations may need to respond to at the same time.

Gaps and Shortcomings: Evaluating new missions: Planners cannot develop requirements, doctrine, etc. for peace support activities and other new missions using traditional modeling techniques.

Political-Military decision-making: The time taken to achieve political consensus has a significant effect on the readiness requirements for forces. There is no ability to analyse this process or measure its impact.

Joint operations: There are currently no models available that adequately represent all aspects of joint operations.

Notes for Slide 7 (Continued)

Integration of models: Each planning discipline employs customised models for its subject area. In addition, within some disciplines (e.g. armaments planning) there are unconnected analysis techniques used for the various warfare areas.

Inclusion of military expertise: It is no longer valid to confine the role of military experts to the beginning and end of the analysis process. With the advent of new missions there is a need for military staff to: provide input assumptions (planners), provide data on effectiveness of forces and support resources (operators), provide assistance on setting up CGFs (operators), participate in simulation as a role player (operators), validate results (planners, operators).

Notes for Slide 7 (Continued)

Representation of C3I: While it may be possible to use existing C3I architectures to meet training and exercise needs, analysis support to planning must evaluate future C3I architectures to determine requirements for hardware, software, communications, information management/display and information warfare and the effect of these aspects on force capability. There is no modeling architecture to simulate C3I processes and thereby establish these requirements.

Rapid force generation and database development: It is extremely time-consuming and manpower intensive to develop force packages and associated data for models used in support of planning. It is rarely the case that data can be re-used due to non-standard models and database representations. Standard synthetic environments are needed to facilitate re-use and introduce more consistency between planning disciplines.

Notes for Slide 7 (Continued)

Goals: 1) There is the need for a consistent modeling capability to support all planning disciplines. The overall long-term goal is to obtain a realistic representation of combined and joint force operations in representative synthetic environments, particularly in the context of peace support operations, 2) It should be flexible enough to allow the inclusion of CGFs, constructive models and role playing by military staff in a cost-effective manner, 3) It should allow closed-loop simulation when it is required to replicate model execution for varying inputs (sensitivity analysis), as well as the ability to operate models interactively to obtain additional insights from the involvement of military decision-makers, 4) It should include representations of C3I systems that are sufficient to allow CIS requirements to be identified and the impact of C3I on force capability, 5) It should be consistent (if not the same) as the architecture used to support training and exercises, operations and acquisition.

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Operations

- Primary use of CGFs
  - planning of operations in advance
  - assessment
  - force generation and deployment planning
  - sustainment planning and logistics
  - ongoing real-time monitoring, controlling, managing and decision making
- Capability Gaps
  - Rapid, automated ability to create, monitor, and regenerate plans
- Goals
  - Speed up decision cycle through faster planning and evaluation

Notes for Slide 8

The integration of simulation with C3I systems, and the use of simulation in operations will help decision making in operational situations. Computer Generated Forces are an essential part in such a system to provide support in situational awareness and course of action generation. The commander will once again become a part of the battle using such tools.

The following aspects of operations and types of missions would benefit from the use of CGFs: Contingency Planning (planning of operations in advance), Intelligence (assessment), Deployment (force generation and deployment planning), Sustainment (sustainment planning and logistics), and Current Operations (ongoing real-time monitoring, controlling, managing and decision making)

Gaps: The primary gap is the ability for rapid automated plan generation and analyses. Without this, CGF behaviors are less flexible. If humans take on the planning role, the time and resource burden would be significant, and in some cases the simulation could not meet the time requirements.

Goals: The pace of decision making must be changed dramatically in the future will change in order to conduct operations before the opposing side is able to react in an ordered way (“fight within the enemy decision cycle”).

Notes for Slide 8 (Continued)

Current Operations as basic function will change in this respect from only monitoring to performing tasks that are at the moment handled within Contingency Planning (e.g. replanning).

The amount of information and the availability in real-time will increase dramatically.

Distribution and execution of orders will be much faster to take advantage of a faster decision making.

The size of staff and forces will be reduced.

The personnel will be familiar with information technology means and demand it.

Decision support is needed from the highest military level down to platoon level.

Key features of CGFs to support these goals include: Real time/Rapid option generation with explanation capability and distributed co-operative planning; Quick Rehearsal (of generated options); Rapid Analysis (of quick rehearsal results)

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Acquisition and Procurement

- Primary use of CGFs
  - Represent systems during all acquisition phases to identify requirements, examine supportability issues, plan for testing, and training
- Capability Gaps
  - Integrated simulation assessment environment
- Goals
  - Methods to represent information systems
  - Support for periodic technology insertion
  - Incentives for private industry investment in CGFs

Notes for Slide 9

As defense budgets and personnel declined, important new factors are emerging. The defence industrial sector is consolidating, forcing Defence to consider commercial vs. military technologies. With Defence comprising a smaller market for these companies, there may be little choice. Whether this strategy is effective is not yet known. From the perspective of industry, as Defence becomes a smaller market, they may have less incentive to develop innovative alternative concepts for the future needs, or to participate in the entire span of the acquisition process. These effects place a greater portion of the development risk on the government.

In the case of information technologies, the commercial world spends significant time and resources to determine if devices (e.g., computer interfaces, telephone keypads) are effectively used. The operational environments in defence applications are much more complex by comparison, yet we have neither the established methodology nor the experienced practitioners. Key issues include the need to assess information flows and how these can bring about new command structures. A second issue is how to match user capabilities to advanced command and control equipment. If Nations adopt different strategies (e.g., stable force structures vs. improved usability technology), keeping interoperable systems across technology generations is problematic.

Notes for Slide 9 (Continued)

The milestone process plus the long development times work against inserting new technologies. The analyses to support a design are based on a hierarchy of increasingly more detailed models, used in a sequential manner. The architecture of these assessment tools lacks flexibility, and the computer representation of the system cannot portray multiple levels of detail in a consistent manner throughout all assessments. When a new capability is considered (e.g., a new sensor giving the system greater effective range), the entire sequence of studies is begun anew, making ready insertion of new technology unobtainable. In areas where a C3I system provides commanders new means to access and assess information, and for which the component technologies are rapidly changing, this long deliberate process limits the effective development of the system.

Gap: Fully integrated assessments are not possible, especially to analyse the contribution of a system to the effectiveness of different echelons. A potential approach is to model forces in terms of the smallest self-contained operational unit. This would promote a more integrated analysis, as it would include aspects important for performing the mission, for maintenance, training, testing, etc. Each system may have a “best” echelon for analysis, so there is a need to perform and then integrate these diverse assessments. This is not readily done today.

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Goals: 1) Integrated Analytic Assessment Environment to develop systems that are robust with respect to threats, missions, and echelons of command, 2) Empirical methods to define, assess requirements for information systems to learn what types of information are needed, by echelon, mission, capabilities of individual commanders in order to support more flexible missions requirements, and in order to better integrate new capabilities into existing military command structures, 3) Design methods that assume periodic insertion of new technologies in order to extend the utility of existing systems, 4) Incentives for private industry to participate in full system development in order to ensure an integrated, end-to-end simulation environment is used to support technology development, concept definition, determination of system requirements, and system development.

Future Developments

- Integrate CGF development with material development
- Establish common databases
- Create CGF architectures that exploit common repositories
- Create simulated environments that are more realistic
  - Especially treatment of information
- Create CGFs to represent commanders at higher echelons

Notes for Slide 10

Activities that can enhance the use of CGFs in the near-term include:

Develop / implement policy that assigns CGF development to material, doctrine, training developers.

Establish commonly used synthetic battlespaces (synthetic environment., CGFs). Continuously upgrade to high resolution as needed.

Develop architectures for CGFs that use data repositories of systems, tactics, doctrine.

Refine linkages between CGF and man-in-the-loop, and with physics-based models.

The longer-term objectives for CGFs will depend on research and development in these areas:

Develop CGFs with explicit treatment of information flows.

Create environments with relevant stimuli for human commanders, individual combatants. Implement assessment methods utilising automatically collected data (from both live players and CGFs).

Develop CGF to represent, in software, the higher echelon or subordinate commanders.

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